24p

62 62613

CONFIDENTIAL

Copy 24
RM SL54C12

N63-12763

Code 1

NACA

RESEARCH MEMORANDUM

for the

U. S. Air Force

THE EFFECT OF SEVERAL JET-ENGINE AIR-INLET

CONFIGURATIONS ON THE LOW-SPEED STATIC LATERAL STABILITY

CHARACTERISTICS OF A 1/6-SCALE MODEL

OF THE MX-1764 AIRPLANE

By Delwin R. Croom

Langley Aeronautical Laboratory
Langley Field, Va.

CLASSIFICATION CHANGED TO
UNCLASSIFIED - AUTHORITY:
NASA - EFFECTIVE DATE
SEPTEMBER 14, 1962

OTS PRICE

XEROX $ 2.60 ph

MICROFILM $ 1.01 mf

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON

MAR 4 1954

UNCLASSIFIED

CONFIDENTIAL

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

for the

U. S. Air Force

THE EFFECT OF SEVERAL JET-ENGINE AIR-INLET CONFIGURATIONS ON THE LOW-SPEED STATIC LATERAL STABILITY CHARACTERISTICS OF A 1/6-SCALE MODEL OF THE MX-1764 AIRPLANE

By Delwin R. Croom

SUMMARY

An investigation was made in the Langley 300 MPH 7- by 10-foot tunnel to determine the effect of wing-root leading-edge- and scoop-type jet-engine air-inlet configurations on the static lateral stability characteristics of a 1/6-scale model of the MX-1764 airplane. Pressure data at a survey station located near the duct exit are presented without analysis for the model with one of the intake configurations at several angles of sideslip and at 0° angle of attack.

The addition of the inlet configurations to the model generally had only small effects on the lateral stability. A previous investigation had shown that the addition of the inlet configurations to the model generally resulted in slight reductions in longitudinal stability and a slight increase in maximum lift coefficient.

INTRODUCTION

An investigation was made in the Langley 300 MPH 7- by 10-foot tunnel of a 1/6-scale model of the MX-1764 airplane. The object of the present investigation was to determine the effect of several jet-engine air-inlet configurations on the static lateral stability characteristics of the model. The longitudinal stability characteristics and the duct-flow characteristics of the model in pitch have been presented in reference 1; however, results for one configuration with the internal duct open and with the internal duct closed are presented in the present paper to show the effect of flow on the longitudinal characteristics of the model. (This would simulate engine failure for this configuration.)

SYMBOLS

The results of the tests are presented as standard NACA coefficients of forces and moments about the stability axes (see fig. 1). The positive direction of forces, moments, and angles is also shown in figure 1. The moment coefficients are given about the 25-percent wing-mean-aerodynamic-chord position as shown in figure 2. The coefficients and symbols are defined as follows:

C_L	lift coefficient, Lift/q_oS
C_X	longitudinal-force coefficient, X/q_oS
C_Y	lateral-force coefficient, Y/q_oS
C_l	rolling-moment coefficient, L/q_oSb
C_m	pitching-moment coefficient, $M/q_oS\bar{c}$
C_n	yawing-moment coefficient, N/q_oSb
$\left.\begin{array}{c}\dfrac{H_o - H_1}{H_o - p_o} \\ \dfrac{H_o - p_1}{H_o - p_o}\end{array}\right\}$	pressure coefficients
X	force along X-axis, lb
Y	force along Y-axis, lb
Z	force along Z-axis (lift equals $-Z$), lb
L	rolling moment about X-axis, ft-lb
M	pitching moment about Y-axis, ft-lb
N	yawing moment about Z-axis, ft-lb

q_o	free-stream dynamic pressure, $\rho V_o{}^2/2$, lb/sq ft
S	wing area, sq ft
b	wing span, ft
$\bar{c}$	wing mean aerodynamic chord, ft
V_o	free-stream velocity, ft/sec
ρ	mass density of air, slugs/cu ft
α	angle of attack of fuselage reference line, deg
β	angle of sideslip, deg
H	total pressure
p	static pressure

$$\left.\begin{aligned} C_{l_\beta} &= \frac{\partial C_l}{\partial \beta} \\ C_{n_\beta} &= \frac{\partial C_n}{\partial \beta} \\ C_{Y_\beta} &= \frac{\partial C_Y}{\partial \beta} \end{aligned}\right\} \text{lateral-stability parameters}$$

Subscripts:

o	free stream
1	condition at survey rake (fig. 3)

MODEL AND APPARATUS

The model used in the present investigation was a 1/6-scale model of the MX-1764 airplane. The wing and tail surfaces had a leading-edge sweep of 55° (with the exception of the vertical tail which had a leading-edge sweep of 58°), taper ratio of zero, and a small amount of sweepback of the trailing edges (10° for the wing and 15° for the tail surfaces). The physical characteristics of the basic model are presented in figure 2.

Plan views of the duct-inlet configurations investigated and location of the tubes in the survey rake are shown in figures 3(a) and (b). Inlets numbers 1 and 3 had the same plan-form characteristics, but the lip of inlet number 3 had a more blunt section than the lip of inlet number 1.

TESTS

The tests were conducted in the Langley 300 MPH 7- by 10-foot tunnel on the single-strut support system at a dynamic pressure of approximately 100 pounds per square foot, which corresponds to an airspeed of approximately 180 miles per hour. Reynolds number for these tests based on a mean aerodynamic chord of the model (22.36 in.), was approximately 3.35×10^6. Tests were made with the jet-engine air-inlet ducts open, except where noted; however, the duct air-flow measurements were made for only one duct configuration.

CORRECTIONS

The angle of attack and drag have been corrected for jet-boundary effects computed on the basis of unswept wings by the method of reference 2. The jet-boundary corrections applied are as follows:

$$\Delta\alpha = 0.591C_L$$

$$\Delta C_X = -0.0103C_L^2$$

Jet-boundary corrections have not been applied to the pitching-moment coefficients because estimations have indicated that these corrections are negligible.

Tare corrections from the single-support strut were not applied to the data. Tare corrections determined on another model of similar size and test setup have shown that the largest effect of the strut is generally on longitudinal-force coefficient and pitching-moment coefficient, which would be increased approximately 0.01 and 0.005, respectively, in the positive direction for the present model.

Corrections have been applied to the data resulting from tunnel air-flow misalinement, tunnel blockage, and longitudinal pressure gradient in the tunnel.

PRESENTATION OF RESULTS

In order to expedite the release of results of the present investigation, the data are presented with a minimum of analysis. The effects of internal flow on the longitudinal aerodynamic characteristics in pitch for the model with inlet number 3 installed are presented in figure 4. The effects of the jet-engine air-inlet configuration on the longitudinal and lateral aerodynamic characteristics in sideslip at an angle of attack of 0° are presented in figure 5. The lateral-stability parameters through the lift-coefficient range obtained from tests at $\pm 5^{\circ}$ sideslip are presented in figure 6.

The addition of the inlets generally had little or no effect on the lateral stability of the model (figs. 5 and 6). The closing of the duct (no internal flow, see fig. 4) had very little effect on the longitudinal aerodynamic characteristics of the model with inlet number 3 installed (this would simulate engine failure for this configuration).

Table I gives the pressure coefficients (for the configuration with inlet number 1 through the sideslip range at $\alpha = 0^{\circ}$) in the form $\frac{H_o - H_l}{H_o - p_o}$ for the total-pressure tubes (tubes 1 to 13) and $\frac{H_o - p_l}{H_o - p_o}$ for the static tubes (tubes 14 to 17), as shown in figure 3. In conjunction with these data, the dynamic pressure q_o and the mass density of the air ρ_o are given so that the mass flow of air through the ducts can be obtained. It should be kept in mind that the increment between the pressure coefficients $\frac{H_o - H_l}{H_o - p_o}$ and $\frac{H_o - p_l}{H_o - p_o}$ is a direct indication of the ratio of the dynamic pressure in the duct to the free-stream dynamic pressure.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., February 17, 1954.

Delwin R. Croom

Delwin R. Croom
Aeronautical Research Scientist

Approved: Thomas A. Harris

Thomas A. Harris
Chief of Stability Research Division

epr

REFERENCES

1. Croom, Delwin R.: Effect of Several Jet-Engine Air-Inlet Configurations on the Low-Speed Static Longitudinal Stability Characteristics and Quantity Flow of a 1/6-Scale Model of the MX-1764 Airplane. NACA RM SL54A06, U. S. Air Force, 1954.

2. Gillis, Clarence L., Polhamus, Edward C., and Gray, Joseph L., Jr.: Charts for Determining Jet-Boundary Corrections for Complete Models in 7- by 10-Foot Closed Rectangular Wind Tunnels. NACA WR L-123, 1945. (Formerly NACA ARR L5G31.)

UNCLASSIFIED

TABLE I

PRESSURE COEFFICIENTS $\frac{H_o - H_1}{H_o - p_o}$ FOR TOTAL-PRESSURE TUBES (TUBES 1 TO 13)

AND PRESSURE COEFFICIENTS $\frac{H_o - p_1}{H_o - p_o}$ FOR STATIC TUBES (TUBES 14 TO 17)

[Inlet number 1; ρ = 0.002363, $\alpha = 0^\circ$, q_o = 100.3]

Tube (see fig. 3)	Pressure coefficient					
	$\beta = 0^\circ$	$\beta = 4^\circ$	$\beta = 8^\circ$	$\beta = -2^\circ$	$\beta = -6^\circ$	$\beta = -10^\circ$
1	0.536	0.528	0.545	0.536	0.560	0.560
2	.482	.474	.487	.487	.510	.501
3	.438	.433	.446	.438	.461	.461
4	.408	.411	.413	.413	.436	.436
5	.405	.413	.413	.405	.419	.411
6	.243	.243	.248	.240	.247	.238
7	.158	.151	.158	.158	.164	.148
8	.125	.125	.125	.125	.132	.132
9	.310	.315	.322	.306	.329	.329
10	.449	.443	.446	.446	.461	.461
11	.405	.399	.405	.405	.428	.461
12	.418	.413	.413	.421	.436	.486
13	.611	.602	.610	.610	.625	.658
14	.866	.863	.875	.865	.880	.892
15	.898	.895	.907	.890	.913	.922
16	.873	.865	.878	.865	.888	.902
17	.890	.887	.902	.890	.913	.925

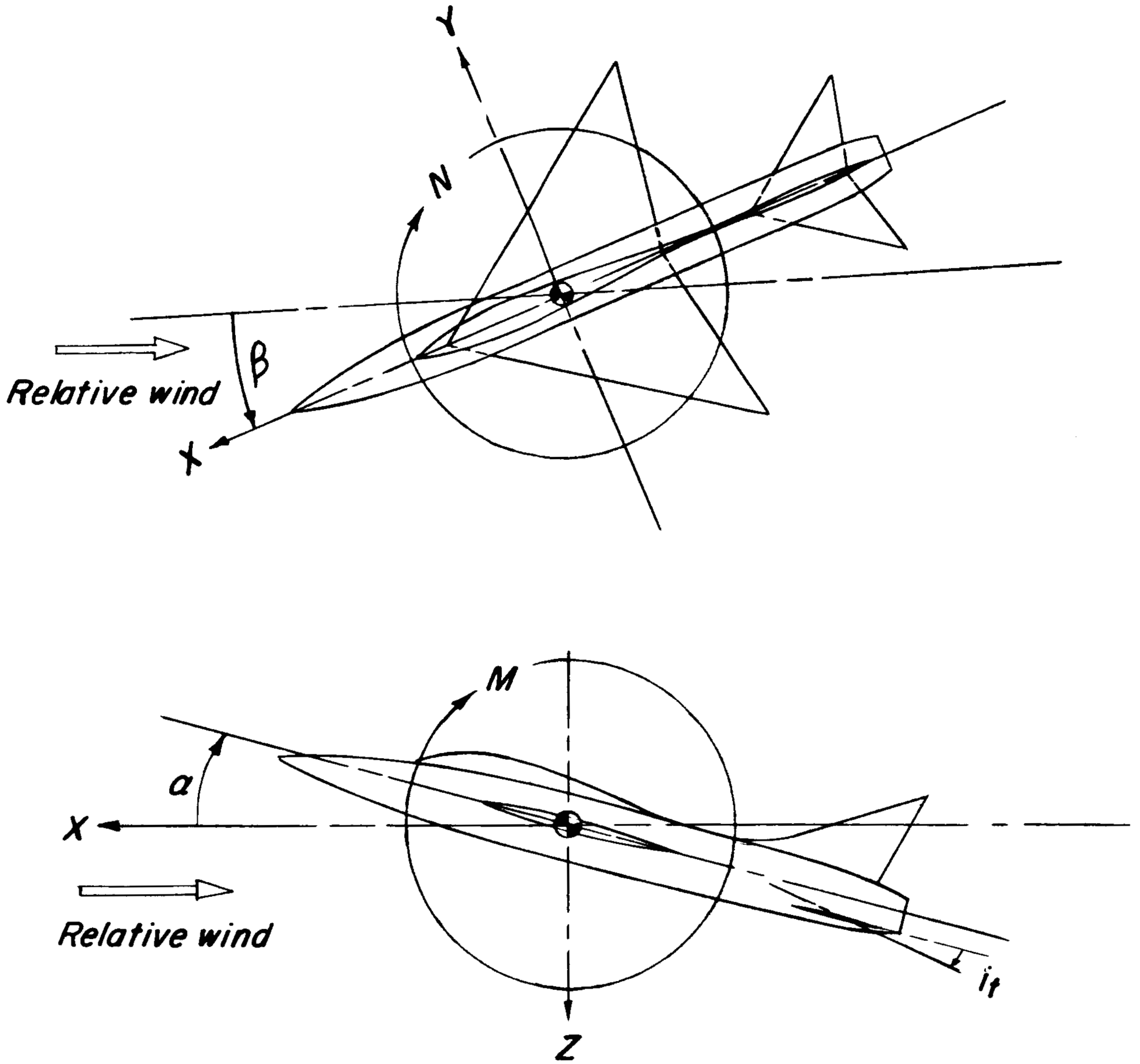
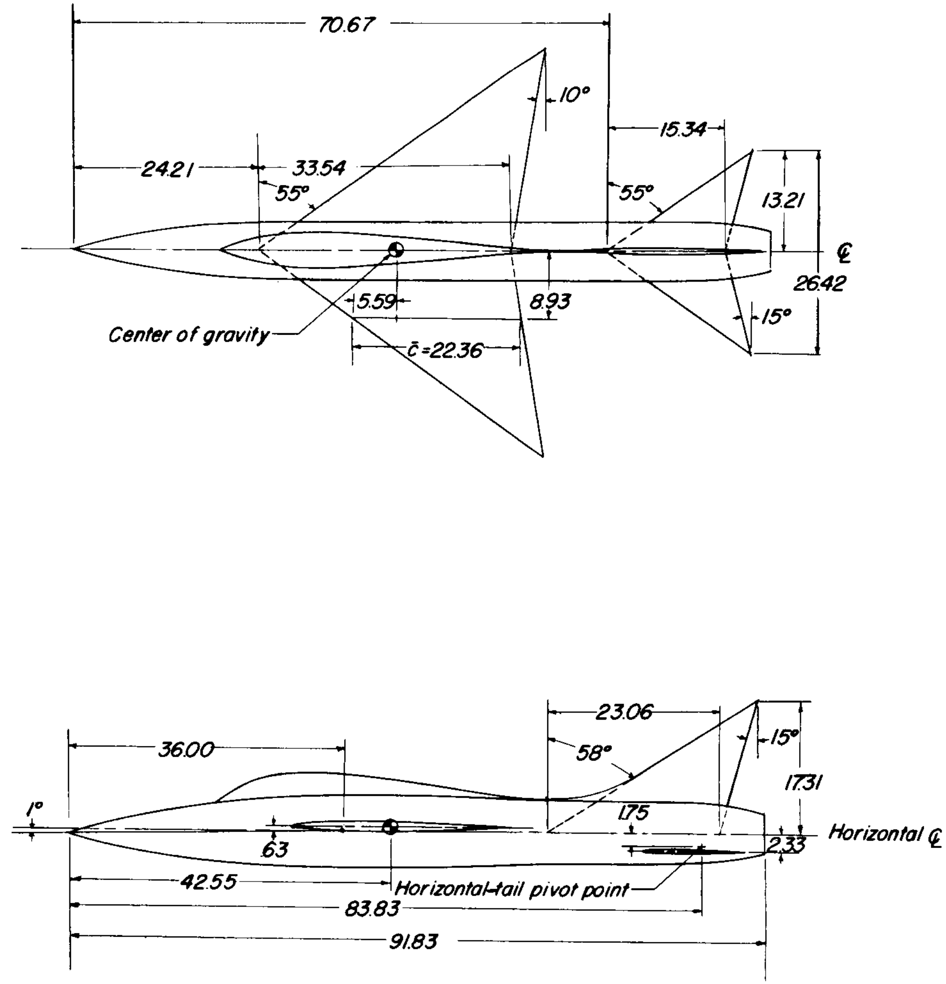


Figure 1.- System of axes and control-surface deflections. Positive direction of forces, moments, and angles is indicated by arrows.

Physical Characteristics

Wing	
Aspect ratio	3.2
Span	53.59 in.
Area	6.25 sq ft
Root chord	33.54 in.
Mean aerodynamic chord	22.36 in.
Airfoil section (parallel to air stream)	65A004.5
Sweepback	
Leading edge	55°
Trailing edge	10°
Incidence	0°
Horizontal tail	
Aspect ratio	3.4
Area (total)	1.41 sq ft
Airfoil section	65A004.5
Vertical tail	
Area (exposed)	.89 sq ft
Airfoil section	65A004.5



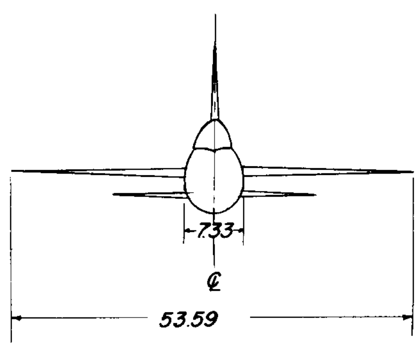
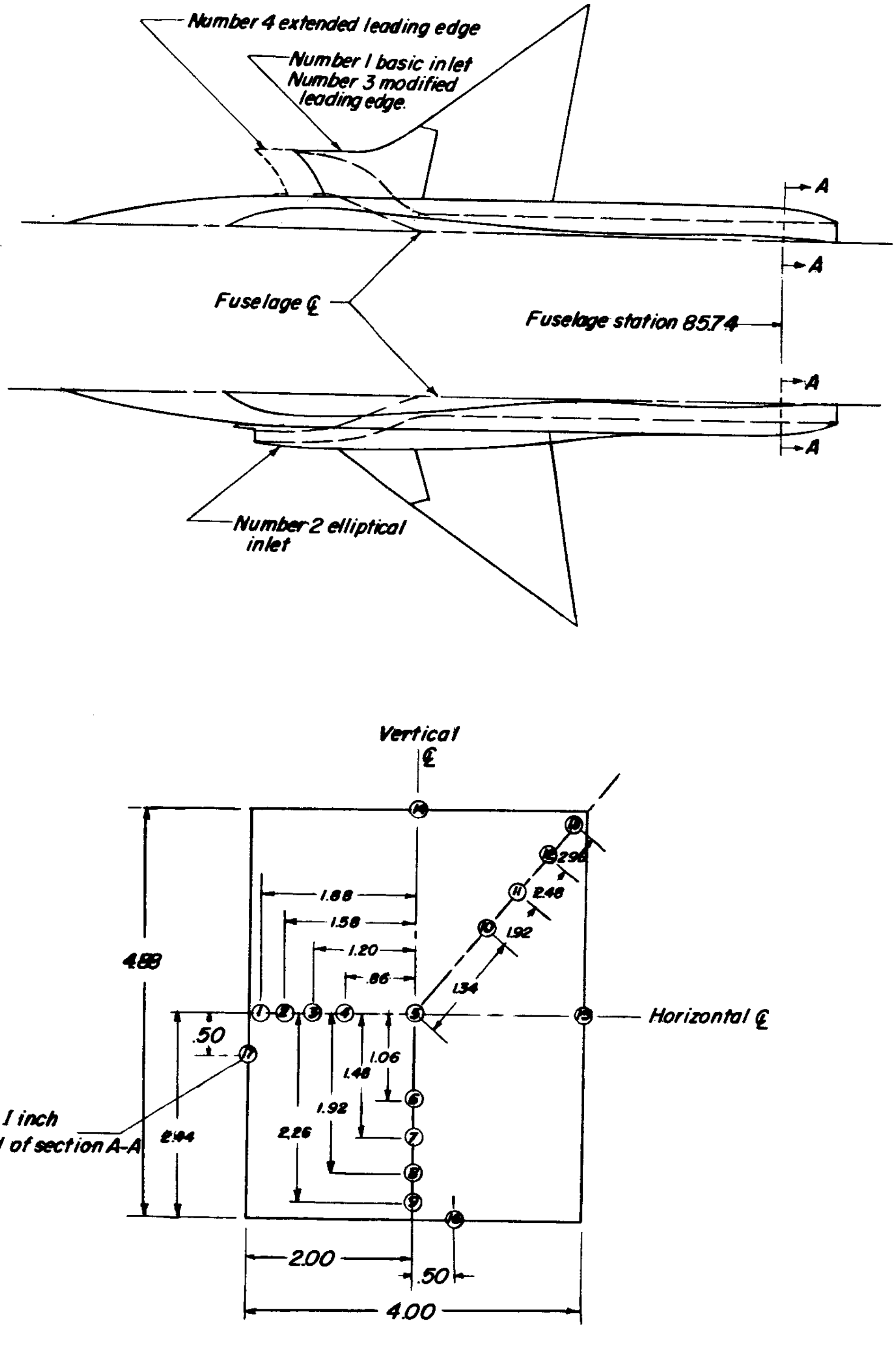
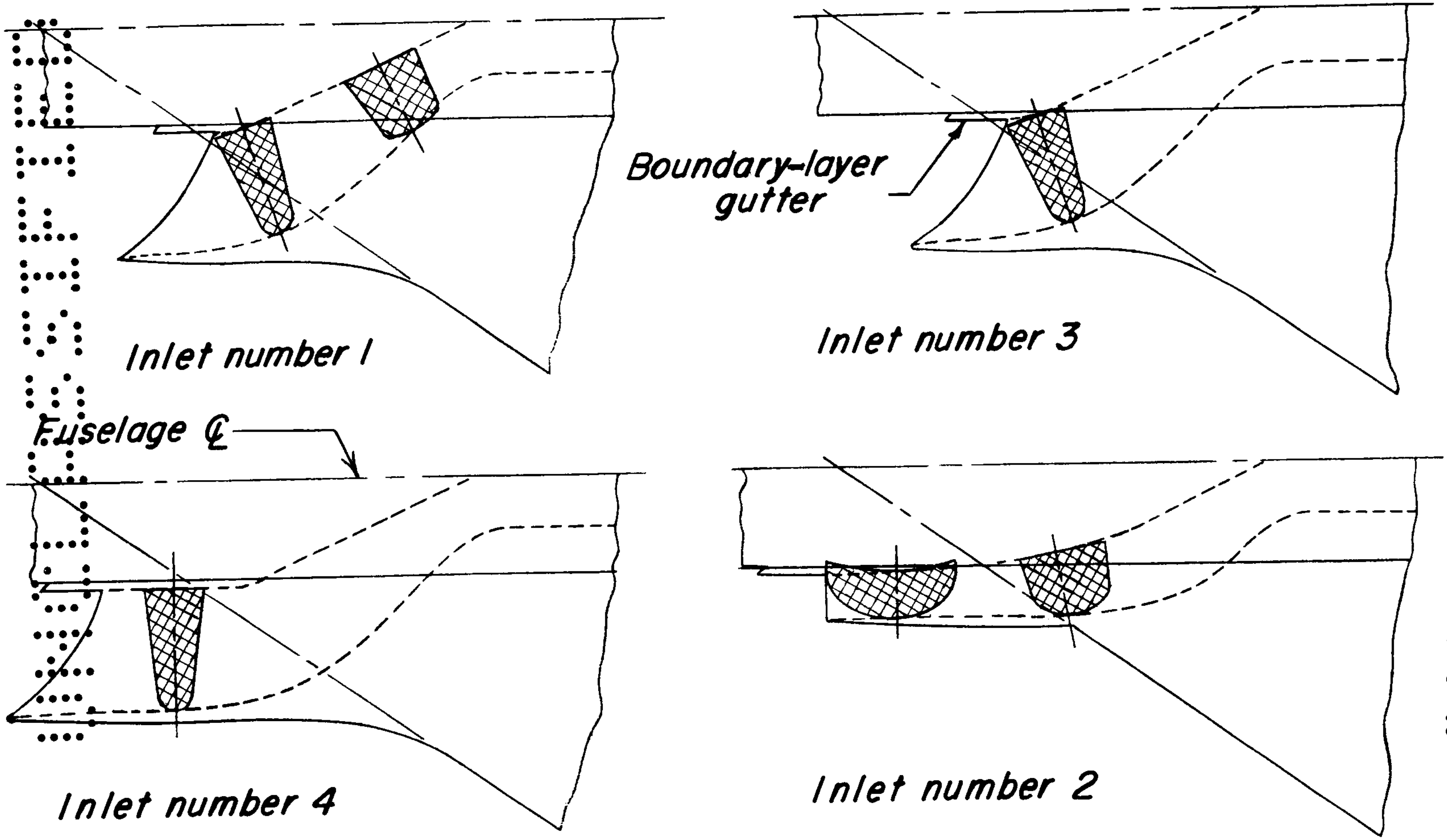


Figure 2.- Three-view drawing of the 1/6-scale model of the MX-1764 airplane. All dimensions are in inches.



(a) Plan view of inlets tested and internal pressure-tube locations.

Figure 3.- Details of inlets and internal pressure-tube locations.



(b) Details of inlets.

Figure 3.- Concluded.

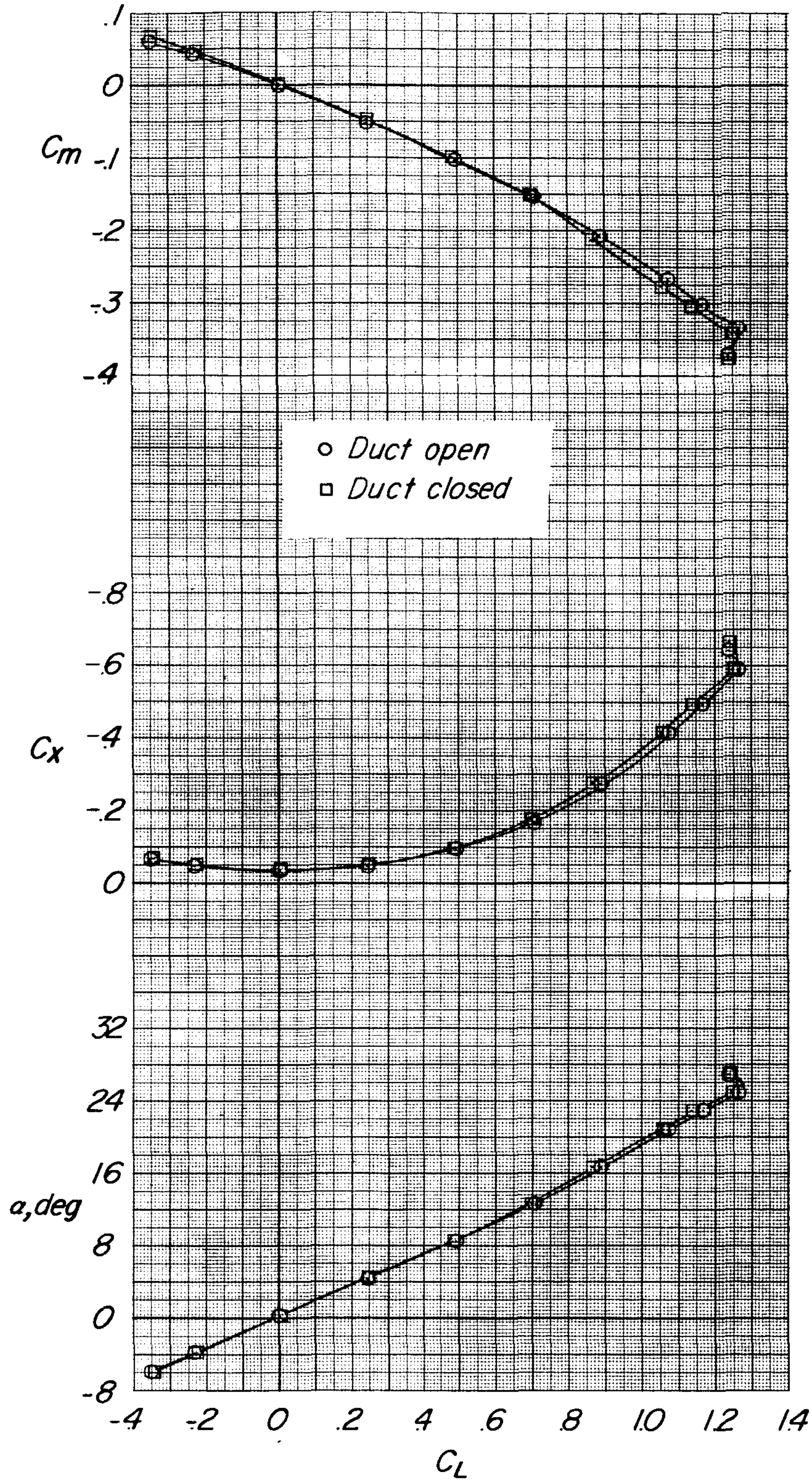
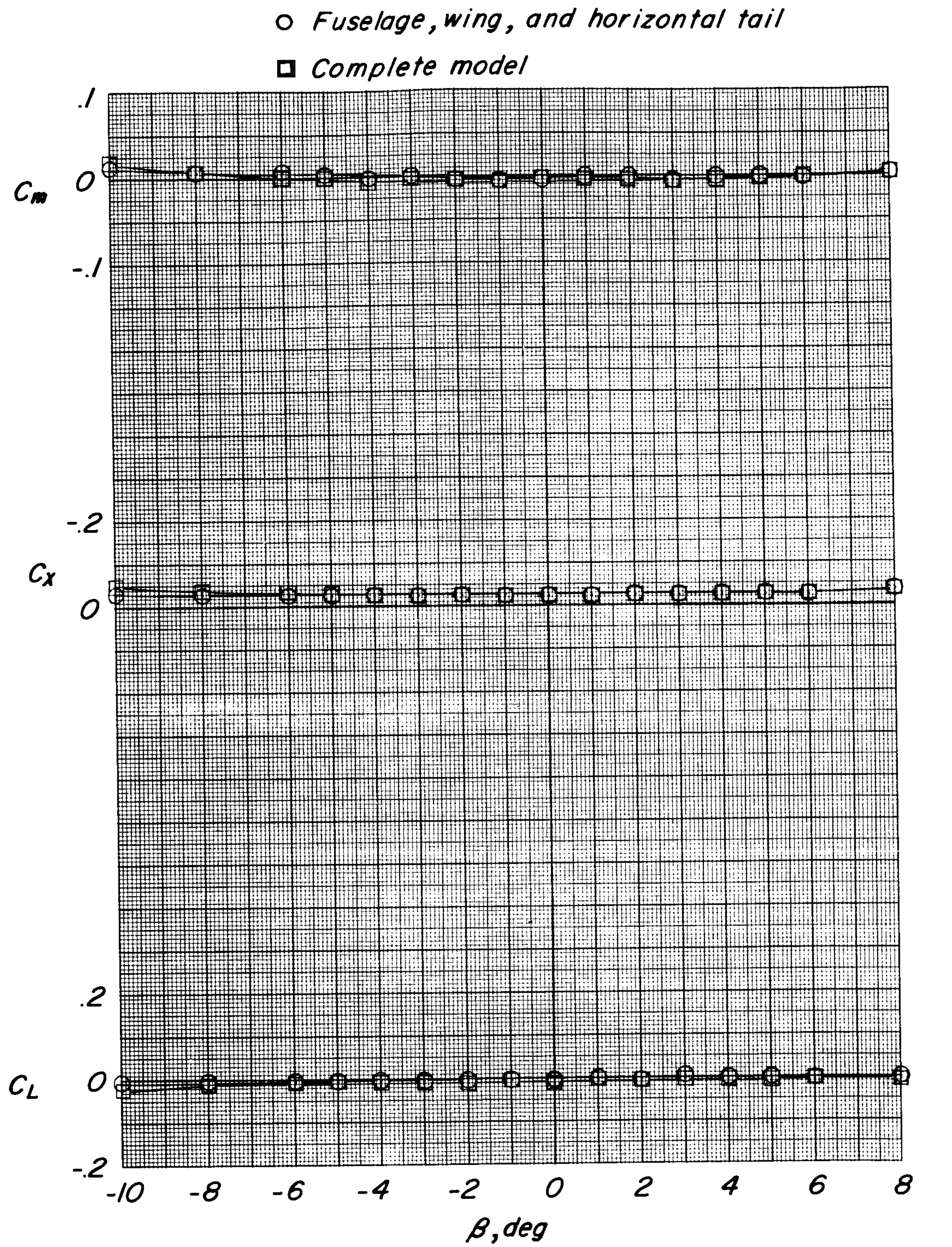
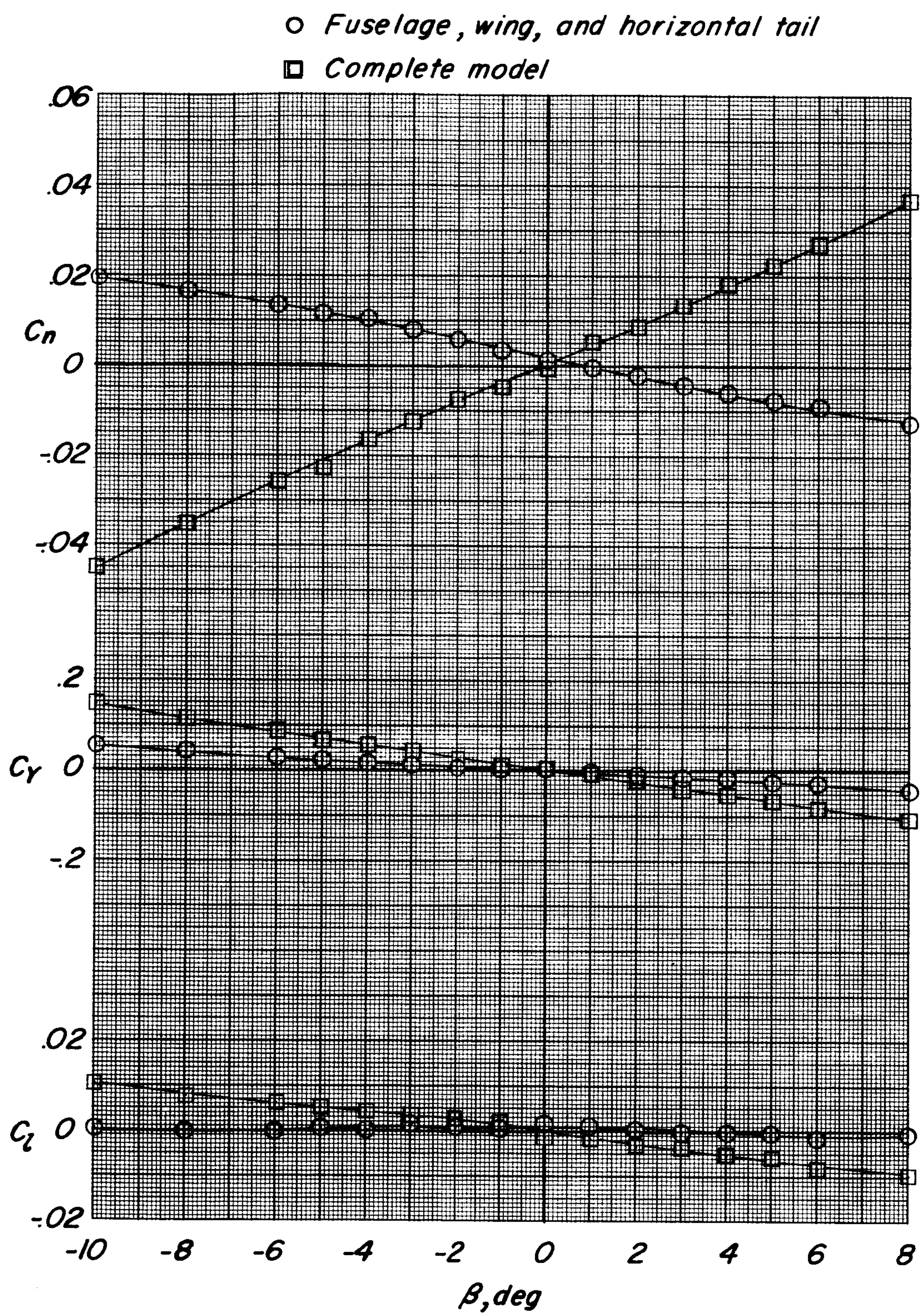


Figure 4.- The aerodynamic characteristics in pitch of the 1/6-scale model of the MX-1764 airplane with inlet number 3. $\beta = 0^{\circ}$.



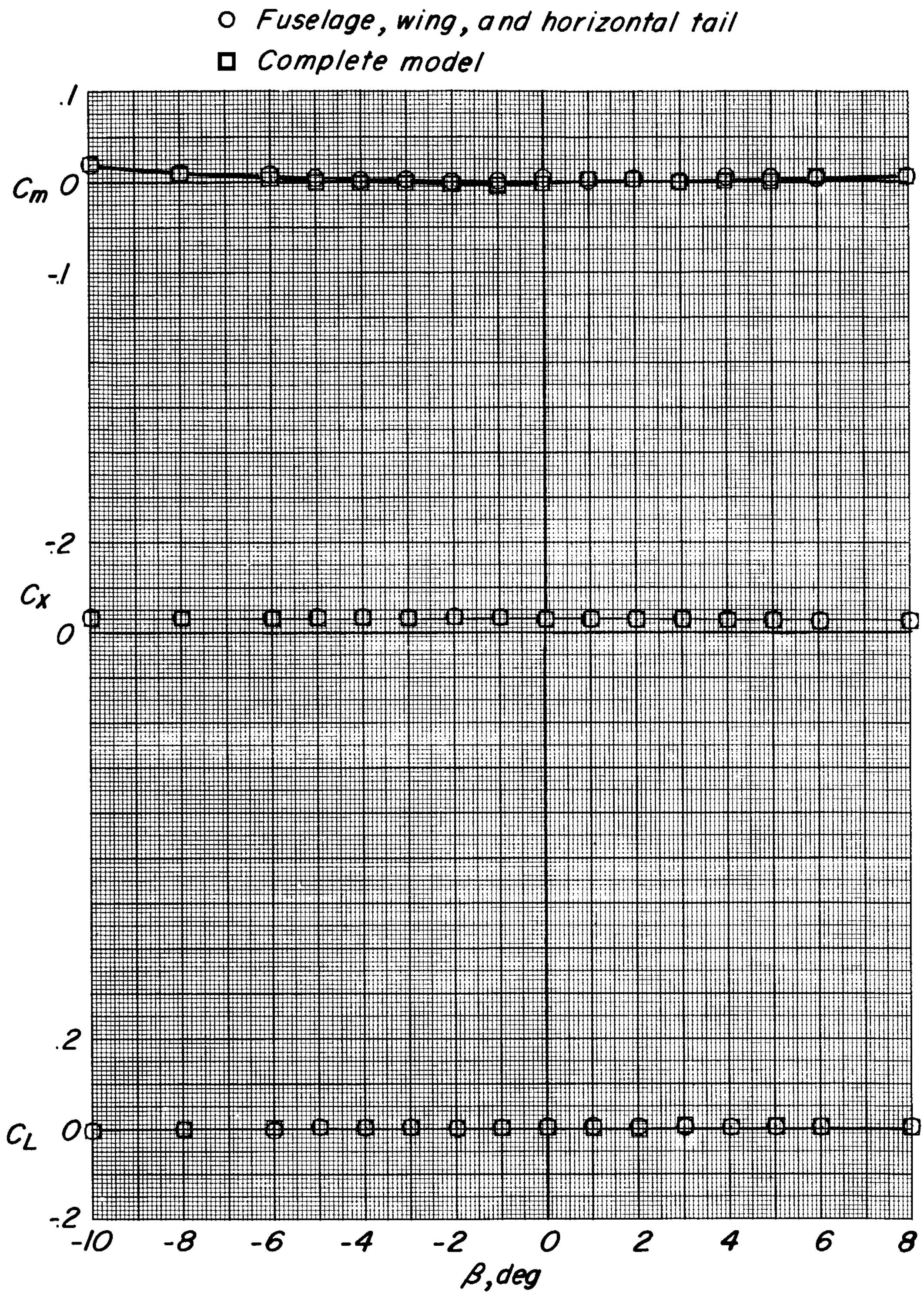
(a) Plain-wing configuration.

Figure 5.- The aerodynamic characteristics in sideslip of the 1/6-scale model of the MX-1764 airplane. $\alpha = 0^{\circ}$.



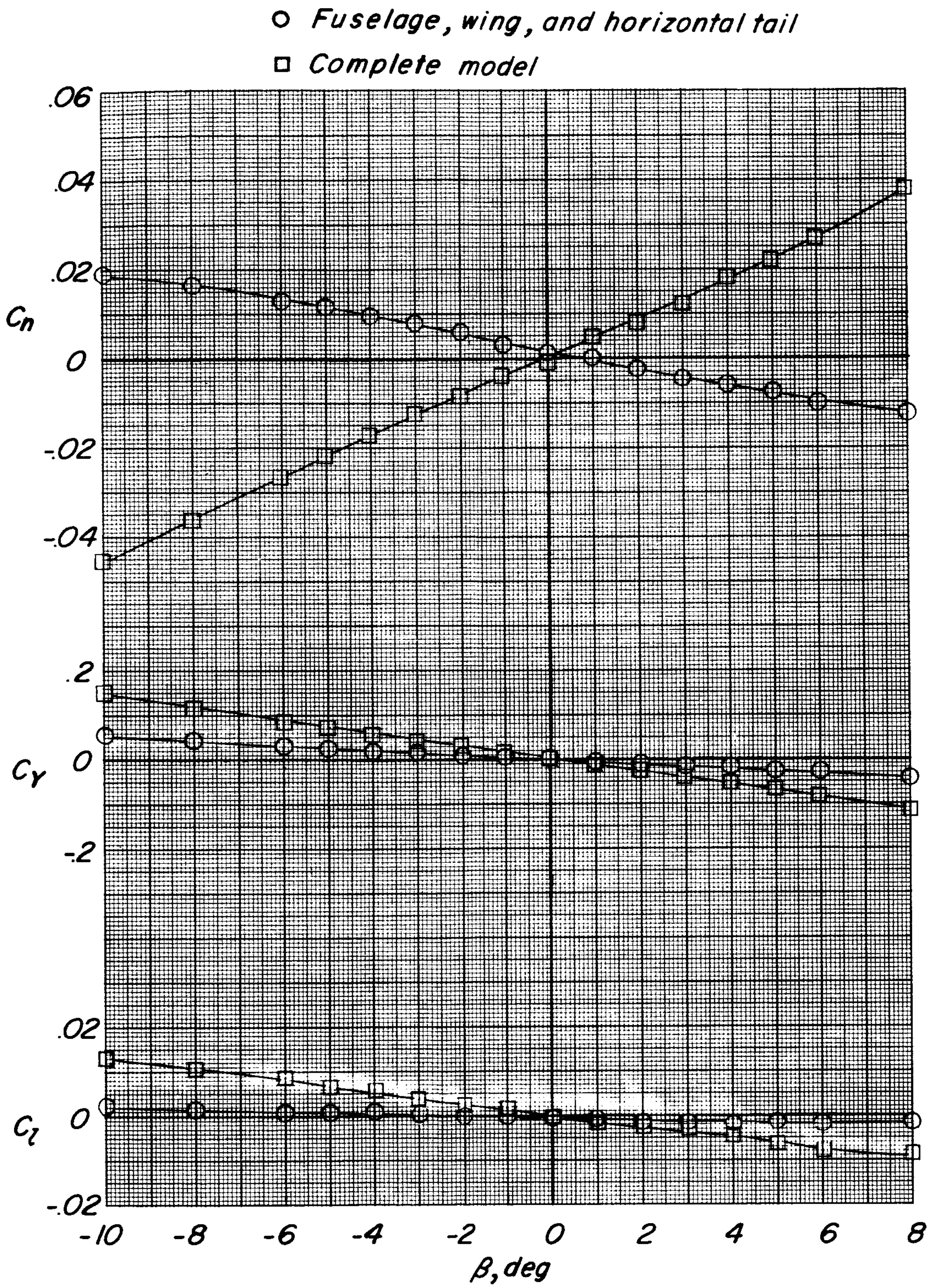
(a) Concluded.

Figure 5.- Continued.



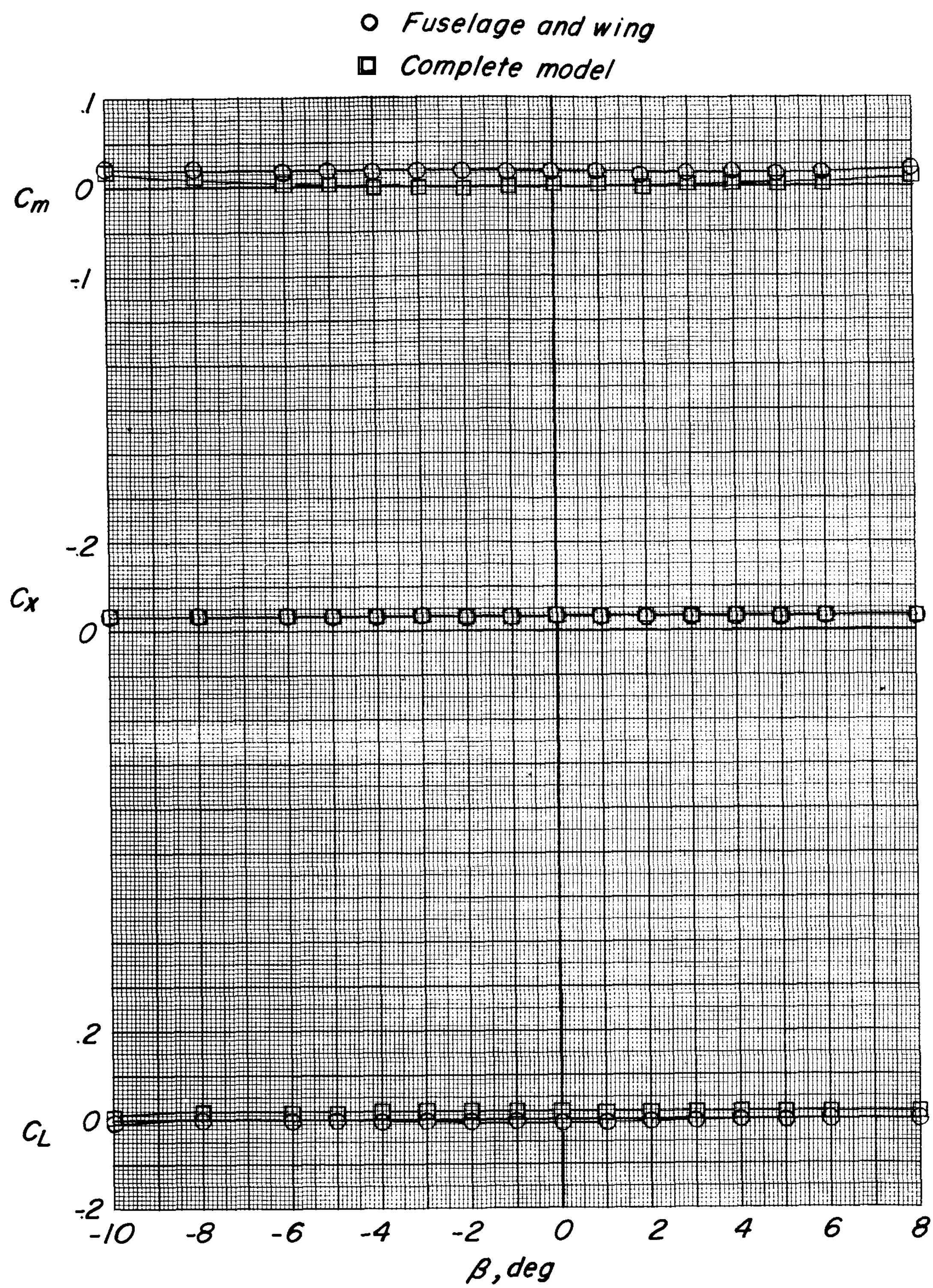
(b) Inlet number 1.

Figure 5.- Continued.



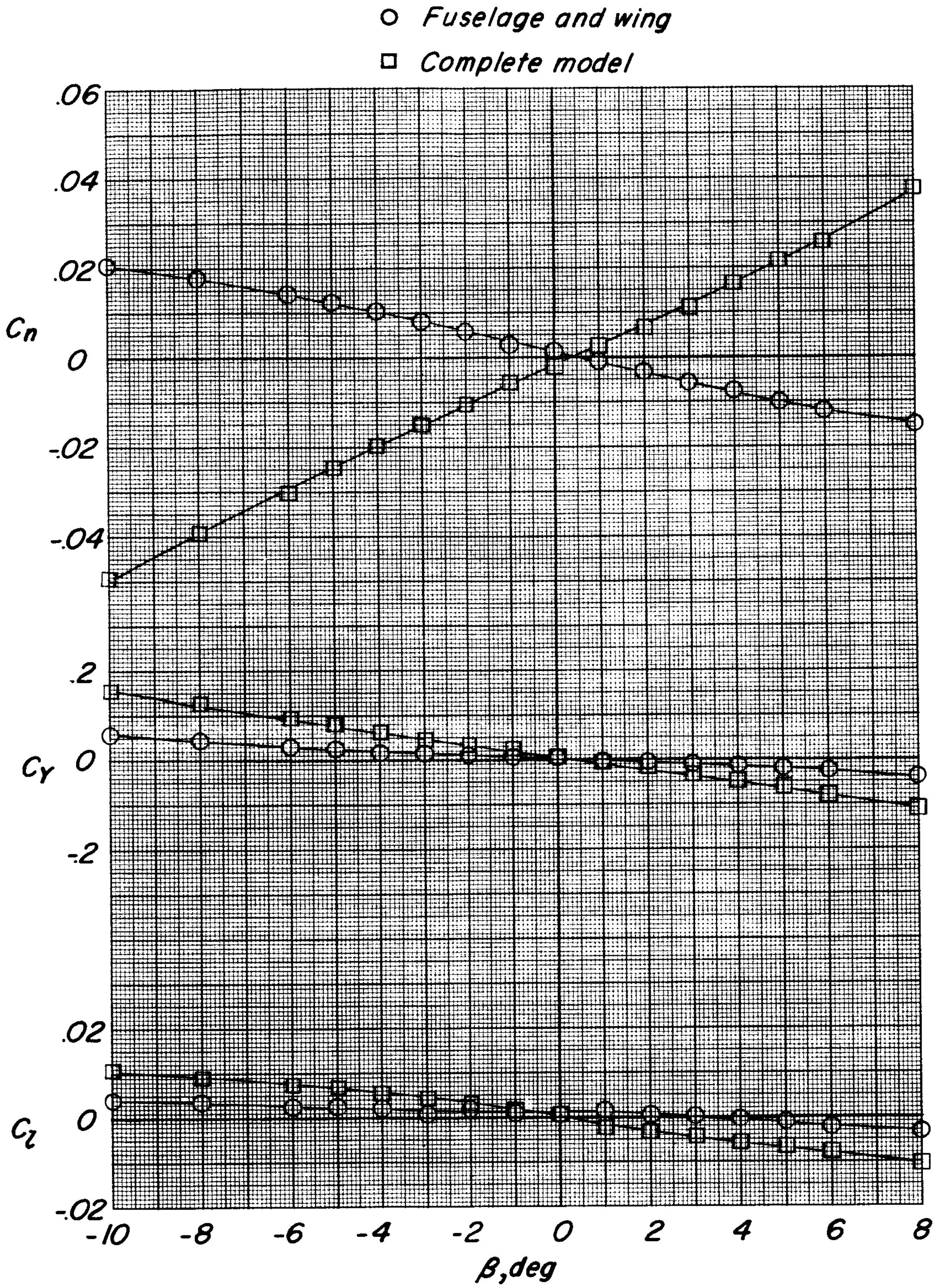
(b) Concluded.

Figure 5.- Continued.



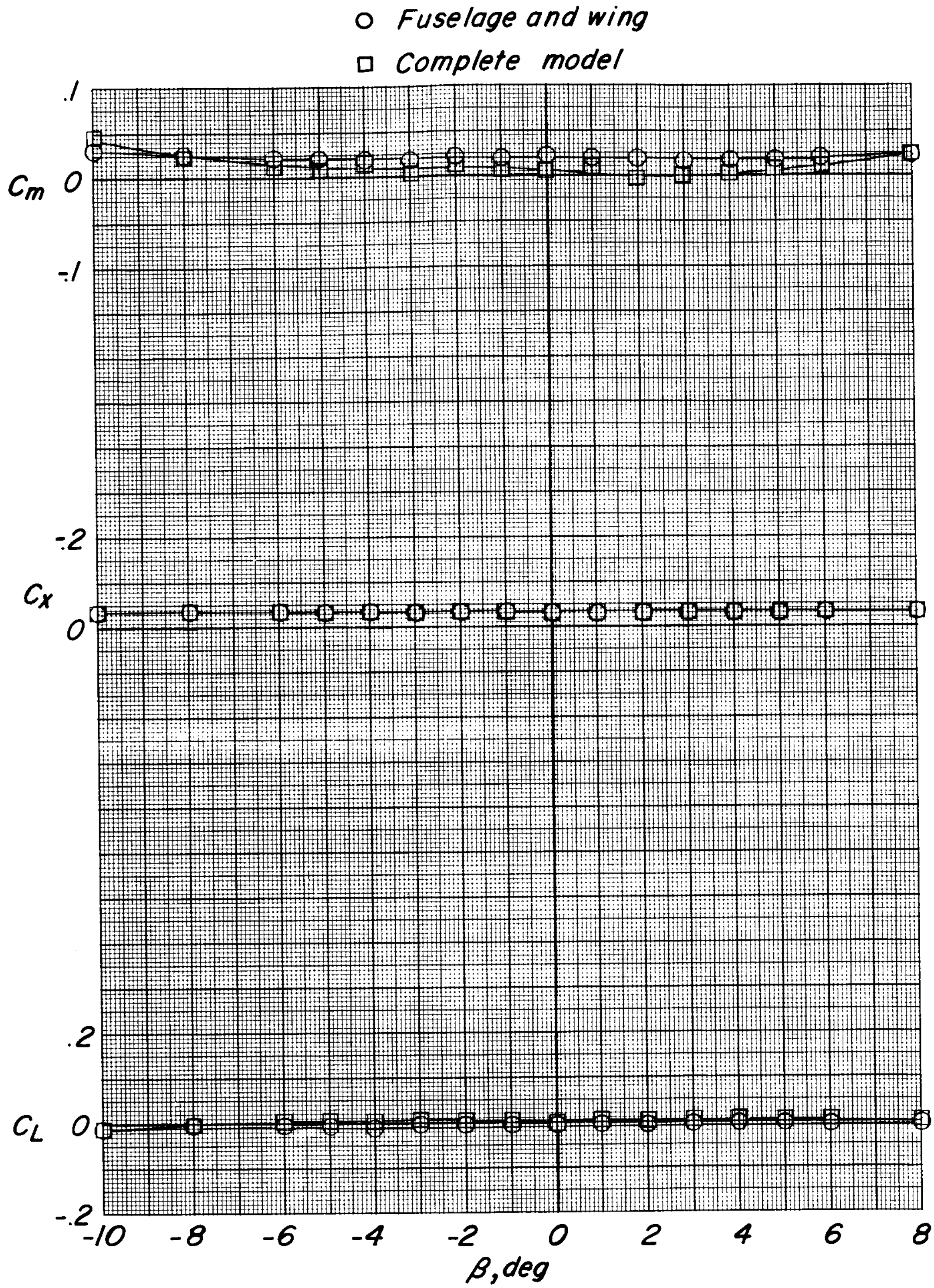
(c) Inlet number 3.

Figure 5.- Continued.



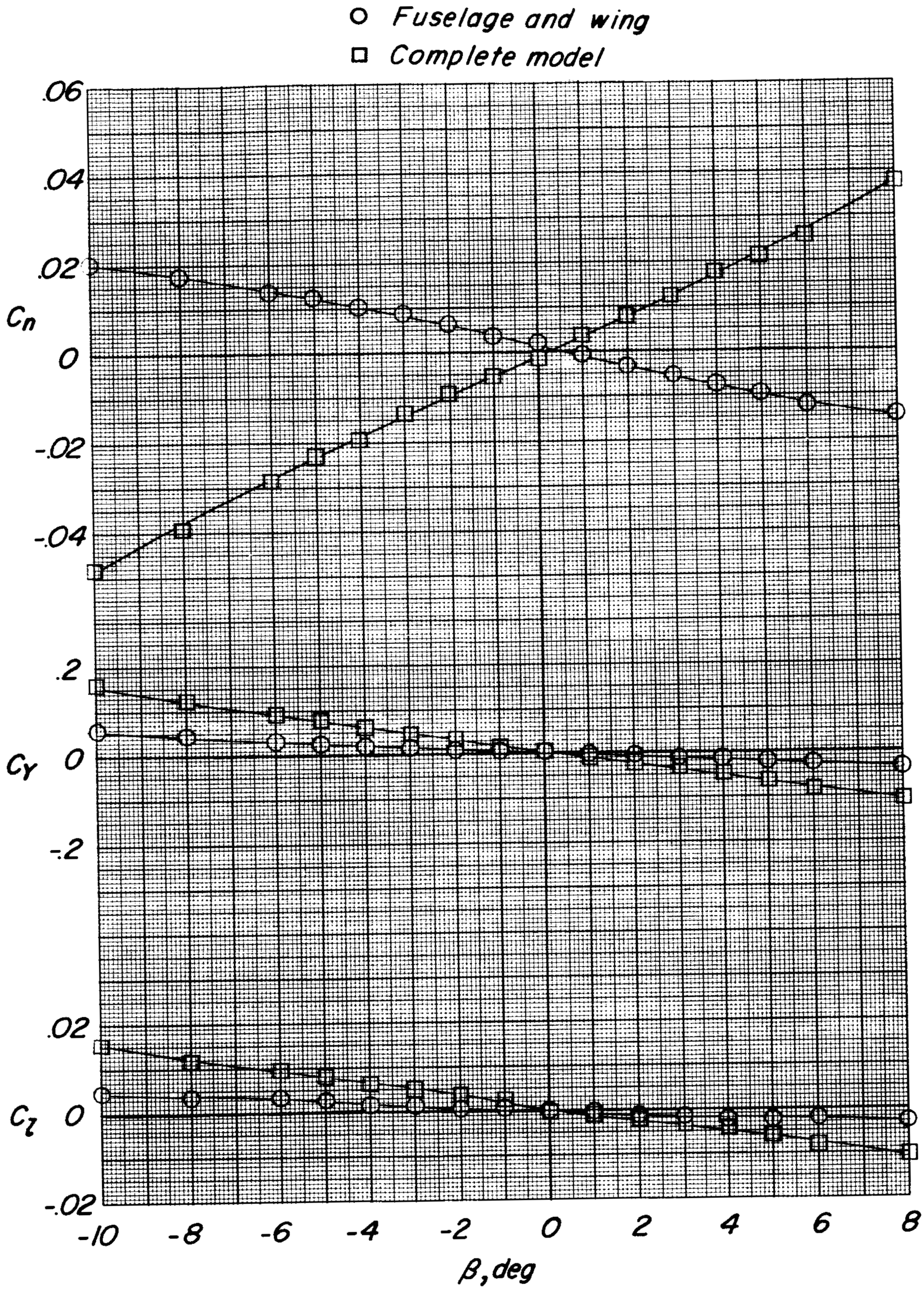
(c) Concluded.

Figure 5.- Continued.



(d) Inlet number 4.

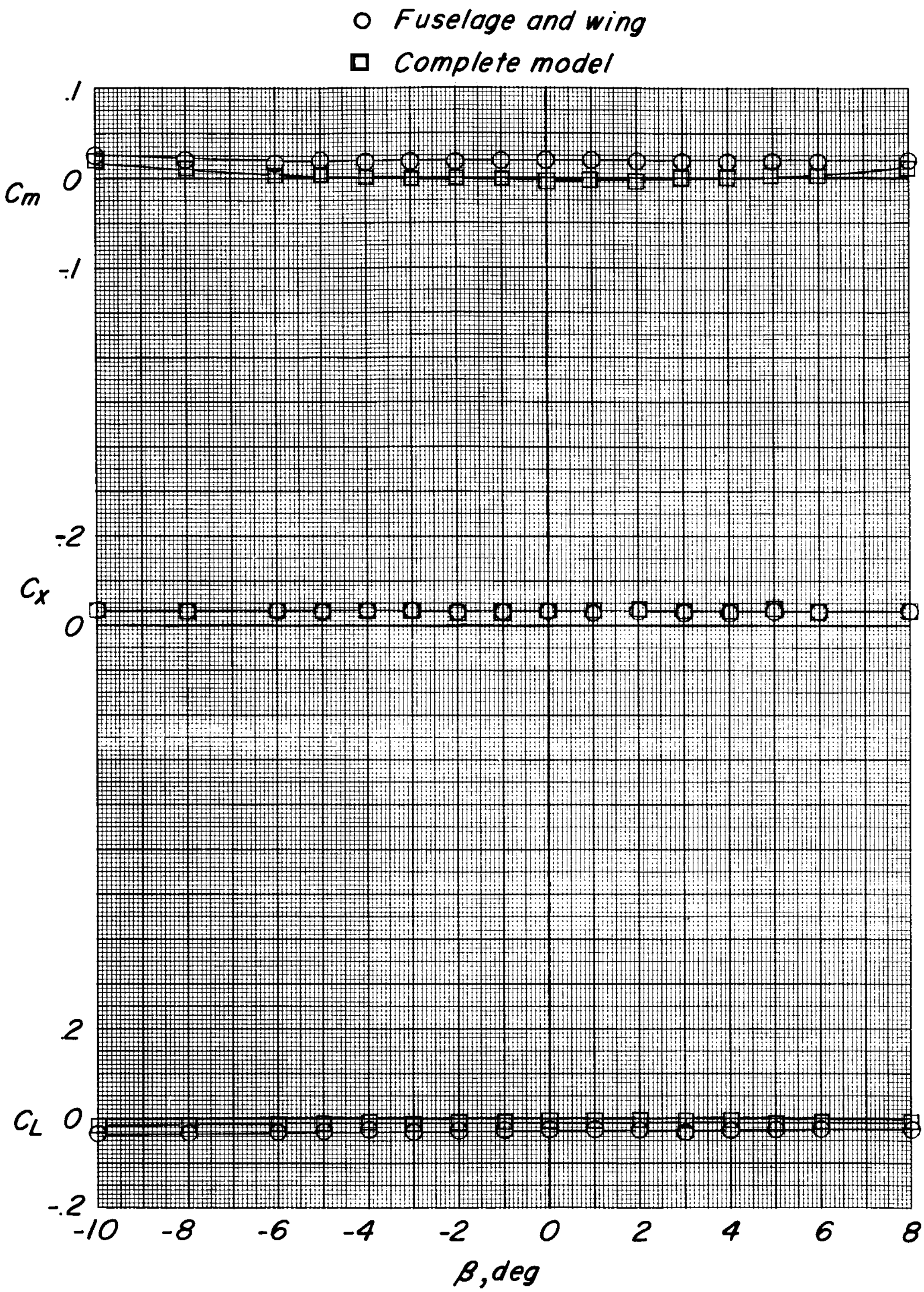
Figure 5.- Continued.



(d) Concluded.

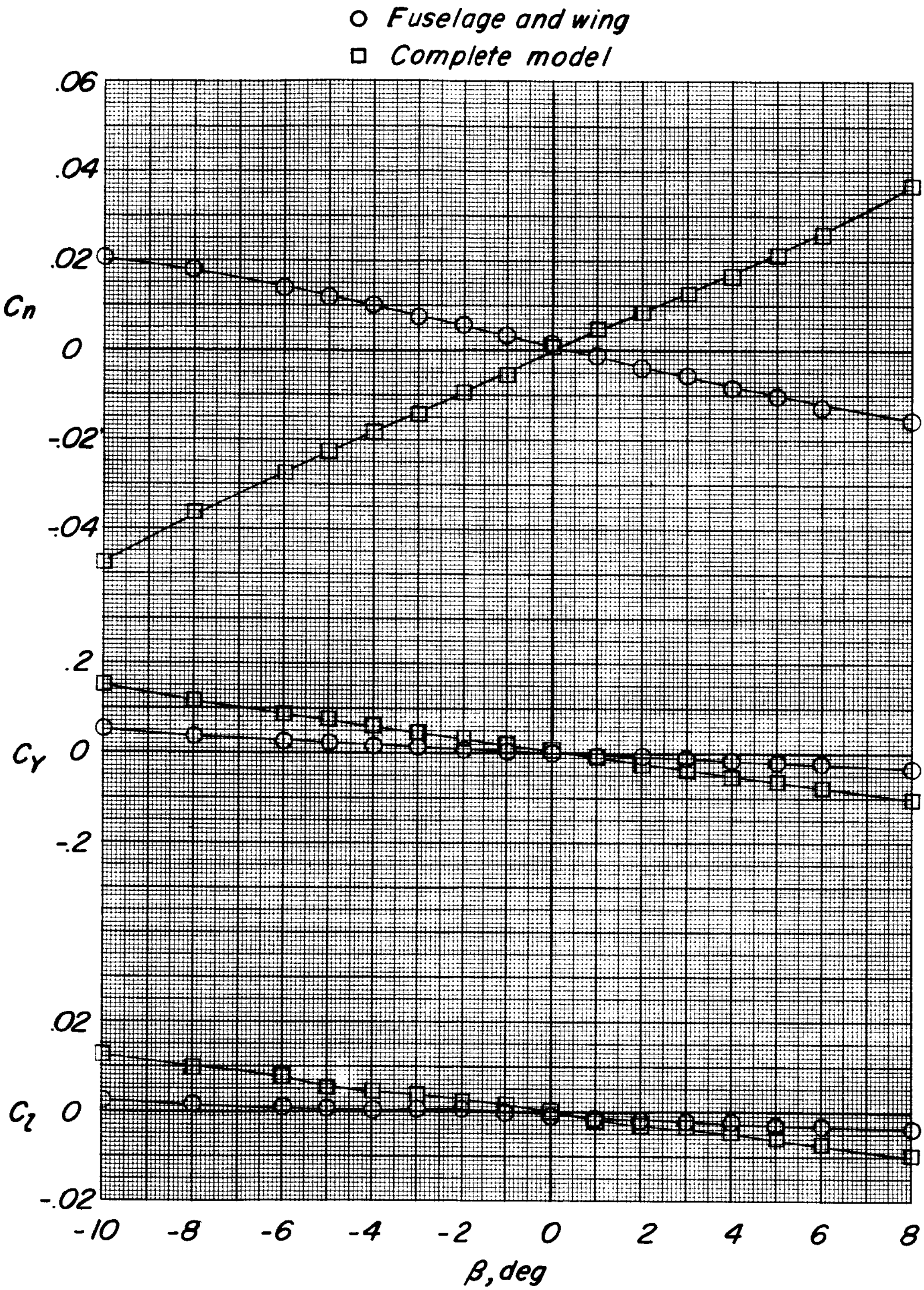
Figure 5.- Continued.

UNCLASSIFIED



(e) Inlet number 2.

Figure 5.- Continued.



(e) Concluded.

Figure 5.- Concluded.

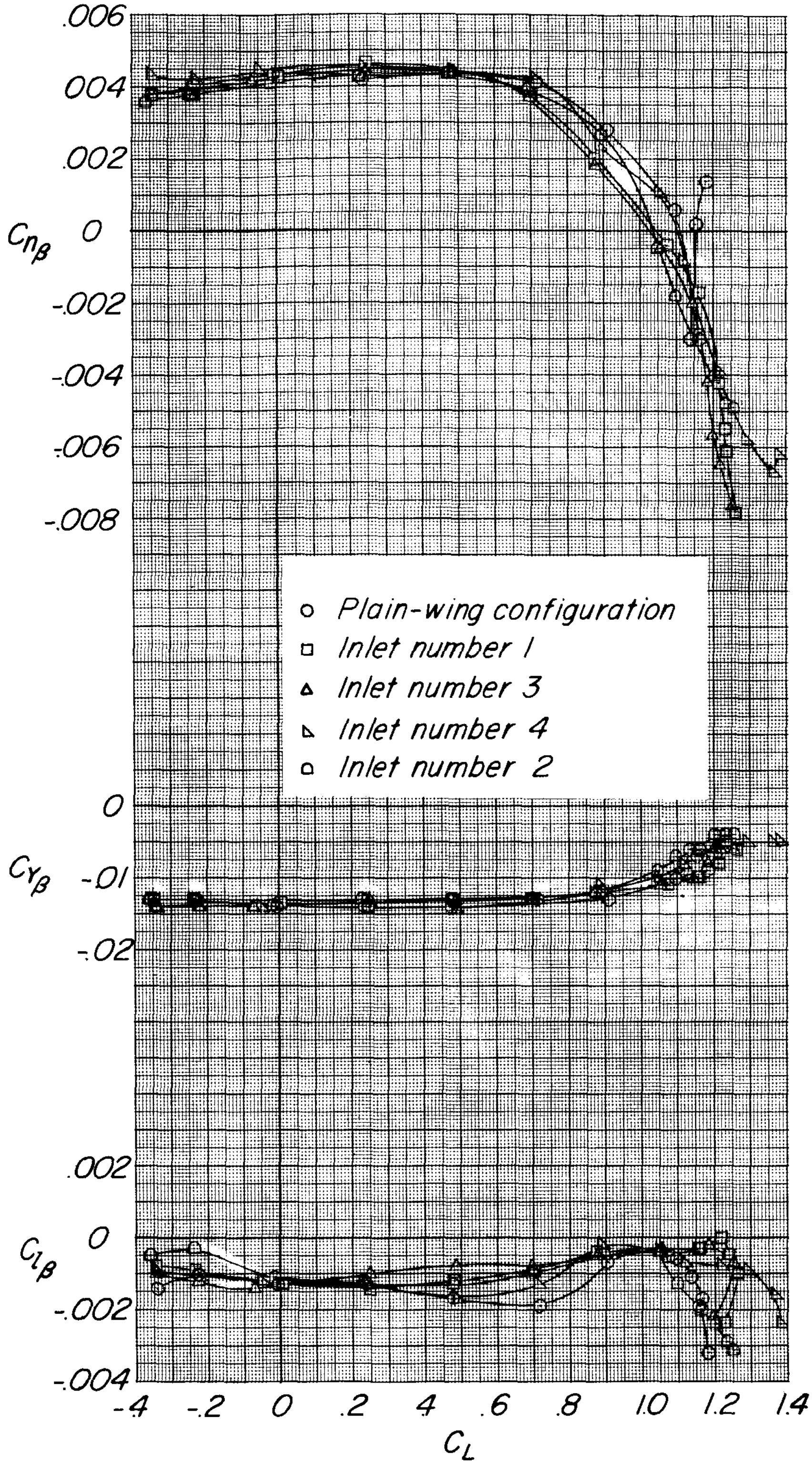


Figure 6.- Effect of wing-root inlet configuration on the variation of the lateral-stability parameters with lift coefficient.